Ensemble Methods for Coastal Ocean Flows

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Award Number: N00014-08-1-0563
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LONG-TERM GOALS

The long-terms goals of this research are to improve our ability to understand and predict environmental conditions in the coastal ocean.

OBJECTIVES

The central objective of the proposed research is to explore problems in coastal ocean modeling, including ensemble forecasting, Lagrangian trajectory analysis, and the utility of Lyapunov vectors for dynamical analysis and ensemble prediction of coastal ocean flows. The research will be conducted by an incoming graduate student, in collaboration with the PI.

APPROACH

The proposed research is extending previous work on these topics by directly addressing issues in coastal ocean modeling, including especially Lagrangian motion during wind-driven coastal upwelling. The research is being carried out primarily by a graduate student, with assistance from and guidance by the PI. The details of the graduate student research project are being guided in part by the specific interests of the student.

The main approach taken is to use high-resolution numerical simulations of wind-driven coastal upwelling to explore and quantify the characteristics and statistics of Lagrangian trajectories in the coastal ocean. Under this grant, the focus has been on the advection of neutrally modified temperature and salinity fields in upwelling source regions identified by Rivas and Samelson (2010) for simulations of Oregon coast upwelling circulation during the year 2005. Rivas and Samelson (2010) used a backward-time particle-tracking method to identify these source regions. That approach does not take account of diffusive modification of water parcels by sub-grid-scale mixing turbulence parameterizations. The approach taken under this grant extends those results by modifying the upstream source-water temperature-salinity properties, in such a way as to preserve density as closely as possible, and then detecting the resulting downstream changes in temperature and salinity in the upwelling region.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **2010**	2. REPORT TYPE	3. DATES COVERED **00-00-2010 to 00-00-2010**
4. TITLE AND SUBTITLE **Ensemble Methods for Coastal Ocean Flows**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Oregon State University,College of Oceanic and Atmospheric Sciences,104 COAS Admin Bldg,Corvallis,OR,97331-5503**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR’S ACRONYM(S)
		11. SPONSOR/MONITOR’S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**3**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

WORK COMPLETED

Several sets of simulations for year 2005, with various different density-compensated modifications of temperature and salinity in various different source regions, have been completed and analyzed.

RESULTS

The results of the analysis provide independent support for the particle-tracking conclusions regarding the locations of upwelling source waters, as the modified temperature and salinity properties are detectable downstream, in the upwelling region (Fig. 1). The results further indicate that along-path mixing has a substantial influence on the amplitude of the temperature and salinity response in the upwelling region, relative to the amplitude of the imposed upstream changes. Additional results are described in the report for the grant "Coastal Ocean Modeling & Dynamics" (N00014-10-1-0531), which is the continuation of the present grant.

IMPACT/APPLICATIONS

The results have impact and application for understanding of biological and any other related Lagrangian processes in the coastal zone, including dispersal of passive floating or submerged objects, and development of extreme biological conditions such as hypoxia or anoxia.

RELATED PROJECTS

The grant "Coastal Ocean Modeling & Dynamics" (N00014-10-1-0531) is the continuation of the present grant.

REFERENCES

Rivas, D., and R. M. Samelson, 2010. A numerical modeling study of the upwelling source waters along the Oregon coast during 2005. J. Phys. Oceanogr., accepted.

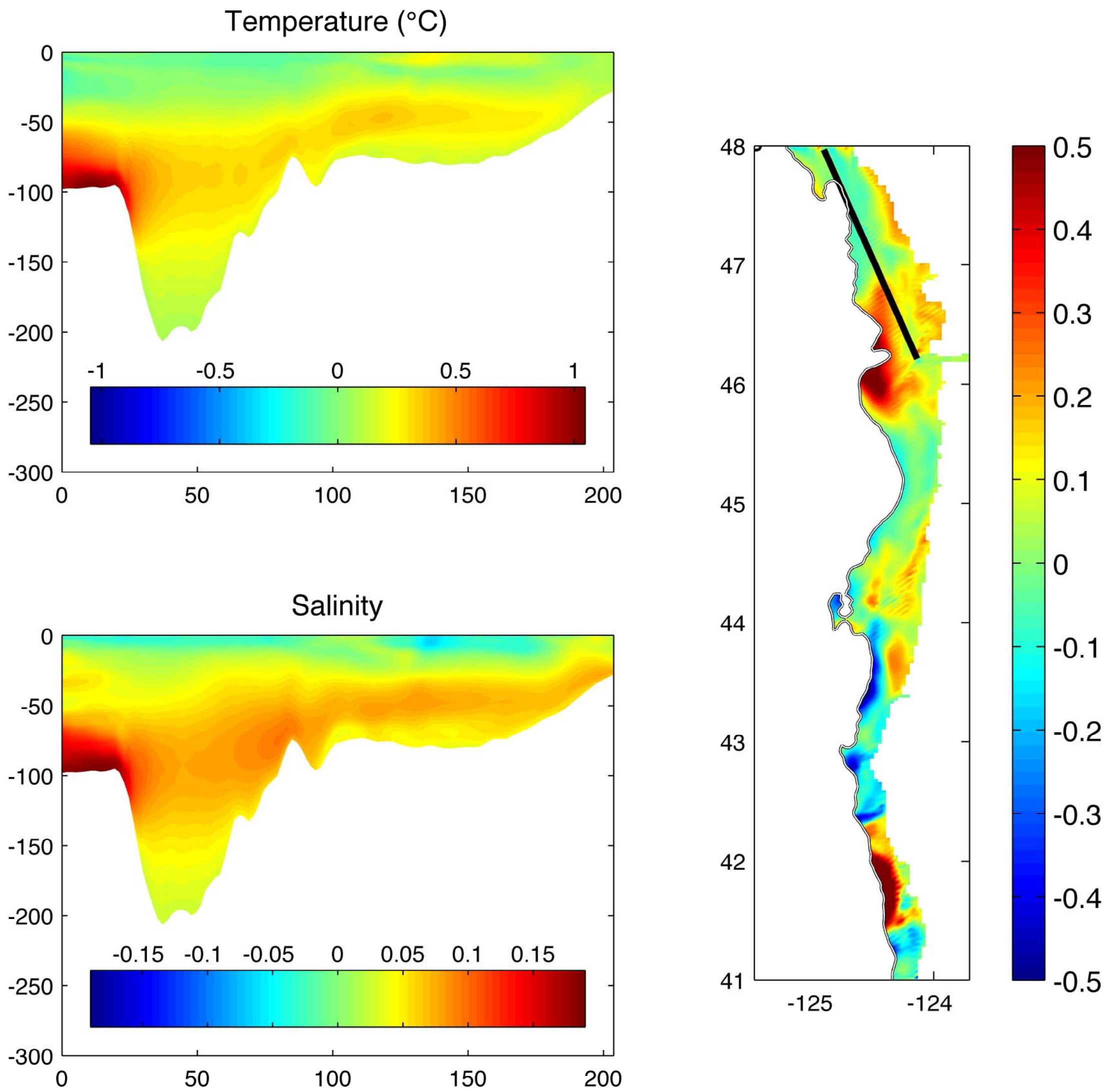

Figure 1. Temperature (^oC) and salinity (psu) differences along the Oregon shelf from the control simulation during July 2005, for a simulation with modified, density-compensated, temperature and salinity at the northern upwelling source region identified through particle-tracking by Rivas and Samelson (2010). Southward propagation along the shelf and upwelling of the modified fluid is evident in the vertically averaged temperature difference (right panel; offshore boundary of contoured region is at 200-m isobath) and the sections of temperature (upper left) and salinity (lower left) difference along the indicated line (solid line, right panel).